

CERTIFICATE OF ELECTRONIC TRANSMISSION

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Appln. of: SAITO et al.

Appln. No.: 10/823,474

Filed: April 13, 2004

For: SELF-PINNED CPP GIANT
MAGNETORESISTIVE HEAD WITH
ANTIFERROMAGNETIC FILM
ABSENT FROM CURRENT PATH

Examiner: Craig A. Renner

Art Unit: 2627

Confirmation No. : 4590

Attorney Docket No: 13652-52

AMENDMENT

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Commissioner for Patents
P.O. Box 1450
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Dear Sir:

This amendment is submitted in response to the Final Office Action dated October 20, 2008. Applicants respectfully request that the Examiner withdraw his rejections to the claims in view of the amendments and remarks herein.

Listing of claims begins on page 2.

Remarks begin on page 9.

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application.

LISTING OF CLAIMS

1. (Currently Amended) A CPP giant magnetoresistive head comprising:
lower and upper shield layers with a predetermined shield distance therebetween;
a giant magnetoresistive (GMR) element disposed between the upper and lower shield layers, the GMR element having a group of adjacent parallel layers, the group comprising a pinned magnetic layer, a free magnetic layer and a nonmagnetic layer disposed between the pinned magnetic layer and the free magnetic layer, the CPP giant magnetoresistive head being free of an antiferromagnetic layer between the upper and lower shield layers that passes generally perpendicularly through a vertical plane drawn through the group of adjacent parallel layers in a thickness direction, wherein a current flows in a direction of the vertical plane; and
wherein the pinned magnetic layer includes a laminated ferrimagnetic structure comprising a first pinned magnetic sublayer and a second pinned magnetic sublayer which are laminated with a nonmagnetic intermediate layer disposed therebetween, wherein the pinned magnetic layer extends to a rear of the nonmagnetic layer and the free magnetic layer, in a height direction, and a dimension of the pinned magnetic layer in a height direction is larger than that in a track width direction, wherein the pinned magnetic layer comprises a magnetic material having a positive magnetostriction constant, and an end of the pinned magnetic layer is exposed at a surface facing a recording medium.
2. (Cancelled)
3. (Currently Amended) The CPP giant magnetoresistive head according to claim 1, wherein the first and second pinned magnetic sublayers partially or entirely comprise Fe-Co-Cu (wherein Fe > 10 atomic percent, Co > 30 atomic percent, and Cu >

5 atomic percent), Fe-Co-Cu-X (wherein X is at least one element of Pt, Pd, Mn, Si, Au, and Ag), or Co₂MnY (wherein Y is at least one element of Ge, Si, Sn, and Al).

4. (Withdrawn) The CPP giant magnetoresistive head according to claim 1, further comprising an antiferromagnetic layer provided in a rear of the giant magnetoresistive element in the height direction, for pinning the magnetization direction of the pinned magnetic layer in the height direction.

5. (Withdrawn) The CPP giant magnetoresistive head according to claim 4, wherein the antiferromagnetic layer is an insulating antiferromagnetic layer comprising Ni-O or α -Fe₂O₃.

6. (Withdrawn) The CPP giant magnetoresistive head according to claim 4, wherein the antiferromagnetic layer comprises an insulating antiferromagnetic comprising Ni-O or α -Fe₂O₃ and an antiferromagnetic metal layer interposed between the insulating antiferromagnetic layer and the pinned magnetic layer.

7. (Currently Amended) A CPP giant magnetoresistive head comprising:
lower and upper shield layers with a predetermined shield distance therebetween;
a giant magnetoresistive (GMR) element disposed between the upper and lower shield layers, the GMR element having a group of adjacent parallel layers, the group comprising a pinned magnetic layer, a free magnetic layer and a nonmagnetic layer disposed between the pinned magnetic layer and the free magnetic layer, the CPP giant magnetoresistive head being free of an antiferromagnetic layer between the upper and lower shield layers that passes generally perpendicularly through a vertical plane drawn through the group of adjacent parallel layers in a thickness direction, wherein a current flows in a direction of the vertical plane; and

The CPP giant magnetoresistive head according to claim 1, further comprising large-area nonmagnetic metal films provided between the giant magnetoresistive element and the lower shield layer and between the giant magnetoresistive element and the upper shield layer, respectively, so that the large-area nonmagnetic metal films are

in direct contact with the pinned magnetic layer and the free magnetic layer and have larger areas than those of the pinned magnetic layer and the free magnetic layer, respectively,

wherein the large-area nonmagnetic metal films are in direct contact with the lower shield layer and the upper shield layer respectively,

wherein the pinned magnetic layer includes a laminated ferrimagnetic structure comprising a first pinned magnetic sublayer and a second pinned magnetic sublayer which are laminated with a nonmagnetic intermediate layer disposed therebetween, and

wherein the pinned magnetic layer extends to a rear of the nonmagnetic layer and the free magnetic layer, in a height direction, and a dimension of the pinned magnetic layer in a height direction is larger than that in a track width direction.

8. (Currently Amended) The CPP giant magnetoresistive head according to claim 7, wherein the large-area nonmagnetic metal film disposed between the giant magnetoresistive element and the lower shield layer comprises any one of Ta/Cu, Ta/Ru/Cu, Ta/Cr, Ta/Ni-Cr, Ta/(Ni-Fe)-Cr, and Cr, and ~~wherein~~when the composition contains Cr, the Cr content exceeds 20 atomic percent.

9. (Currently Amended) A CPP giant magnetoresistive head comprising;
lower and upper shield layers with a predetermined shield distance therebetween;

a giant magnetoresistive (GMR) element disposed between the upper and lower shield layers, the GMR element having a group of adjacent parallel layers, the group comprising a pinned magnetic layer, a free magnetic layer and a nonmagnetic layer disposed between the pinned magnetic layer and the free magnetic layer, the CPP giant magnetoresistive head being free of an antiferromagnetic layer between the upper and lower shield layers that passes generally perpendicularly through a vertical plane drawn through the group of adjacent parallel layers in a thickness direction, wherein a current flows in a direction of the vertical plane; and

wherein the pinned magnetic layer has a laminated ferrimagnetic structure comprising a first pinned magnetic sublayer and a second pinned magnetic sublayer which are laminated with a nonmagnetic intermediate layer disposed therebetween, wherein the pinned magnetic layer comprises a magnetic material having a positive magnetostriction constant ~~or a magnetic material having high coercive force~~, and an end of the pinned magnetic layer is exposed at a surface facing a recording medium.

10. (Previously presented) The CPP giant magnetoresistive head according to claim 9, wherein a dimension of the pinned magnetic layer in a height direction is larger than the dimension in a track width direction.

11. (Currently Amended) The CPP giant magnetoresistive head according to claim 9, wherein the first and second pinned magnetic sublayers partially or entirely comprise Fe-Co-Cu (wherein Fe > 10 atomic percent, Co > 30 atomic percent, and Cu > 5 atomic percent), Fe-Co-Cu-X (wherein X is at least one element of Pt, Pd, Mn, Si, Au, and Ag), or Co₂MnY (wherein Y is at least one element of Ge, Si, Sn, and Al).

12. (Withdrawn) The CPP giant magnetoresistive head according to claim 9, further comprising an antiferromagnetic layer provided in a rear of the giant magnetoresistive element in the height direction, for pinning the magnetization direction of the pinned magnetic layer in the height direction.

13. (Withdrawn) The CPP giant magnetoresistive head according to claim 12, wherein the antiferromagnetic layer is an insulating antiferromagnetic layer comprising Ni-O or α -Fe₂O₃.

14. (Withdrawn) The CPP giant magnetoresistive head according to claim 12, wherein the antiferromagnetic layer comprises an insulating antiferromagnetic comprising Ni-O or α -Fe₂O₃ and an antiferromagnetic metal layer interposed between the insulating antiferromagnetic layer and the pinned magnetic layer.

15. (Currently Amended) A CPP giant magnetoresistive head comprising:
lower and upper shield layers with a predetermined shield distance
therebetween;

a giant magnetoresistive (GMR) element disposed between the upper and lower shield layers, the GMR element having a group of adjacent parallel layers, the group comprising a pinned magnetic layer, a free magnetic layer and a nonmagnetic layer disposed between the pinned magnetic layer and the free magnetic layer, the CPP giant magnetoresistive head being free of an antiferromagnetic layer between the upper and lower shield layers that passes generally perpendicularly through a vertical plane drawn through the group of adjacent parallel layers in a thickness direction, wherein a current flows in a direction of the vertical plane; and

The CPP giant magnetoresistive head according to claim 9, further comprising large-area nonmagnetic metal films provided between the giant magnetoresistive element and the lower shield layer and between the giant magnetoresistive element and the upper shield layer, respectively, so that the large-area nonmagnetic metal films are in direct contact with the pinned magnetic layer and the free magnetic layer and have larger areas than those of the pinned magnetic layer and the free magnetic layer, respectively,

wherein the large-area nonmagnetic metal films are in direct contact with the lower shield layer and the upper shield layer respectively,

wherein the pinned magnetic layer has a laminated ferrimagnetic structure comprising a first pinned magnetic sublayer and a second pinned magnetic sublayer which are laminated with a nonmagnetic intermediate layer disposed therebetween, and

wherein the pinned magnetic layer comprises a magnetic material having a positive magnetostriction constant, and an end of the pinned magnetic layer is exposed at a surface facing a recording medium.

16. (Original) The CPP giant magnetoresistive head according to claim 15, wherein the large-area nonmagnetic metal film disposed between the giant magnetoresistive element and the lower shield layer comprises any one of Ta/Cu, Ta/Ru/Cu, Ta/Cr, Ta/Ni-Cr, Ta/(Ni-Fe)-Cr, and Cr, and when the composition contains Cr, the Cr content exceeds 20 atomic percent.

17. (Currently Amended) A CPP giant magnetoresistive head comprising:
lower and upper shield layers with a predetermined shield distance
therebetween;

a giant magnetoresistive (GMR) element disposed between the upper and
lower shield layers, the GMR element having a group of adjacent parallel layers, the
group consisting of a pinned magnetic layer, a free magnetic layer and a nonmagnetic
layer disposed between the pinned magnetic layer and the free magnetic layer, wherein
the pinned magnetic layer includes a laminated ferrimagnetic structure consisting of a
first pinned magnetic sublayer and a second pinned magnetic sublayer which are
laminated with a nonmagnetic intermediate layer disposed therebetween; and

large-area nonmagnetic metal films abutting against the GMR element
and the lower shield layer and between the GMR element and the upper shield layer,
respectively, so that the large-area nonmagnetic metal films are in direct contact with
the pinned magnetic layer and the free magnetic layer and have larger areas than those
of the pinned magnetic layer and the free magnetic layer, respectively.

18. (Original) The CPP giant magnetoresistive head according to claim 17,
wherein the large-area nonmagnetic metal films comprise first and second large-area
nonmagnetic metal films, wherein the first large-area nonmagnetic film is located
between the upper shield layer and the free magnetic layer, and wherein the second
large-area nonmagnetic film is located between the lower shield layer and at least one
of the first and second pinned magnetic layers.

19. (Original) The CPP giant magnetoresistive head according to claim 17,
wherein the pinned magnetic layer comprises a magnetic material having a positive
magnetostriction constant or a magnetic material having high coercive force, and an
end of the pinned magnetic layer is exposed at a surface facing a recording medium.

20. (Original) The CPP giant magnetoresistive head according to claim 17,
wherein the first and second pinned magnetic layers partially or entirely comprise Fe-
Co-Cu (wherein Fe > 10 atomic percent, Co > 30 atomic percent, and Cu > 5 atomic

percent), Fe-Co-Cu-X (wherein X is at least one element of Pt, Pd, Mn, Si, Au, and Ag), or Co_2MnY (wherein Y is at least one element of Ge, Si, Sn, and Al).

REMARKS

Claims 1, 3, 7-11, and 15-20 are pending in the application. Claim 2 is cancelled. Claims 1, 7, 8, 9, 15, and 17 are amended. No new matter has been added. The Applicants submit that the cited references as discussed below fail to disclose, alone or combined, all of the features of the amended claims, and respectfully request the rejections be withdrawn.

Rejections under 35 U.S.C. § 112

[a] [d] [e]. Claims 1, 9, and 17 are amended. The phrase "a first pinned magnetic layer and a second pinned magnetic layer" is replaced by "a first pinned magnetic sublayer and a second pinned magnetic sublayer". This is supported by FIG. 1 and [54] that the pinned magnetic layer 31 comprises a first pinned magnetic layer 31a and a second pinned magnetic layer 31c.

[b]. Claim 1 is amended. The phrase "the track width direction" is replaced by "a track width direction".

[c]. Claim 8 is amended. The word "wherein" is replaced by "when".

[f]. The base claims are amended to overcome the indefiniteness and so the dependent claims are allowable over the indefiniteness.

Rejections under 35 U.S.C. § 103(a)

Claims 1, 7, 9, 10, and 15 stand rejected as being unpatentable over Nakatani (US 5,390,061) in view of Coffey (US 5,583,725).

Independent claims 1, 9, and 15 recite a CPP giant magnetoresistive with a pinned layer, "wherein the pinned magnetic layer comprises a magnetic material having a positive magnetostriction constant". Nakatani and Coffey fail to teach or suggest at least this limitation. Accordingly, claims 1, 9, and 15 are patentable for at least this reason.

Furthermore, claims 7 and 15 recite a CPP giant magnetoresistive with large-area nonmagnetic metal films, "wherein the large-area nonmagnetic metal films are in direct contact with the lower shield layer and the upper shield layer respectively". Nakatani and Coffey does not teach or suggest this limitation. Therefore, Applicants respectfully submit that claim 7 and 15 are allowable over the cited references.

Accordingly, Applicants respectfully submit that independent claim 1, 7, 9, and 15 are allowable over the cited references. Claims 3, 8, 10-11 and 16 are allowable at least by virtue of the fact that they depend from allowable independent claims, which are allowable.

Allowable Subject Matter

The examiner suggests claims 17-20 would be allowable if rewritten to overcome the rejections under 35 U.S.C 112. Claim 17 is amended to overcome the indefiniteness and so is allowable. The dependent claims 18-20 are thus allowable.

Conclusion

Based on the above remarks, Applicants respectfully submit that the claims are in condition for allowance. The examiner is kindly invited to contact the undersigned attorney to expedite allowance.

Respectfully submitted,

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